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Publications from the FHWA  
Human Factors ITS contract Research Program  
Office of Safety and Traffic Operations Research and Development

Human Factors ITS Contract Research Program

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**Title:** Assessment of Effect of In-Vehicle Display Systems on Driver Performance

**Contract Number:** DTFH61-89-C-00044

**Prime Contractor:** The University of Michigan

**Purpose:** This effort developed initial in-vehicle display prototypes and evaluated human performance using them.

**Status:** Complete

## Publications:

**Green, P., (edited by D. Boehm-Davis), (1995).** *Human Factors of In-Vehicle Driver Information Systems: An Executive Summary*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-95-014).

**Green, P. (1995).** *Measures and Methods Used to Assess the Safety and Usability of Driver Information Systems*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-94-088).

**Green, P., Levison, W., Paelke, G., and Serafin, C. (1995).** *Preliminary Human Factors Design Guidelines for Driver Information Systems*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-94-087).

**Green, P. (1995).** *Suggested Procedures and Acceptance Limits for Assessing the Safety and Ease of Use of Driver Information Systems*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-94-089).

**Levison, W., and Cramer, N. (1995).** *Description of the Integrated Driver Model*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-94-092).



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**Title:** Human Factors in Advanced Traveler Information Systems and Commercial Vehicles Design Evolution

**Contract Number:** DTFH61-92-C-00102

**Prime Contractor:** Battelle Human Factors Transportation Center

**Purpose:** This study will provide in-vehicle information display and control designers with easy-to-use human factors guidelines.

**Status:** In-Progress

## Publications:

Dingus, T.A., Hulse, M.C., Jahns, S.K., Alves-Foss, J., Confer, S., Rice, A., Roberts, I., Hanowski, R.J., and Sorenson, D. (1997). *Development of Human Factors Guidelines for Advanced Traveler Information Systems and Commercial Vehicles: ATIS/CVO Human Factors Literature Review Supplement*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-96-190).

Kantowitz, B.H., Lee, J.D., and Kantowitz, S.C. (1997). *Development of Human Factors Guidelines for Advanced Traveler Information Systems and Commercial Vehicles: Definition and Prioritization of ATIS/CVO Research Studies*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-96-177).

Lee, J.D., Morgan, J., Wheeler, W.A., Hulse, M.C., and Dingus, T.A. (1997). *Development of Human Factors Guidelines for Advanced Traveler Information Systems and Commercial Vehicles: ATIS and CVO Functional Description*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-95-201).

Clarke, D.L., McCauley, M.E., Sharkey, T.J., Dingus, T.A., and Lee, J.D. (1996). *Development of Human Factors Guidelines for Advanced Traveler Information Systems and Commercial Vehicles: Comparable Systems Analysis*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-95-197).

Dingus, T.A., Hulse, M.C., Jahns, S.K., Alves-Foss, J., Confer, S., Rice, A., Roberts, I., Hanowski, R.J., and Sorenson, D. (1996). *Development of Human Factors Guidelines for Advanced Traveler Information Systems and Commercial Vehicles: Literature Review*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-95-153).

McCallum, M.C., Lee, J., Sanquist, T., and Wheeler, W.A. (1996). *Development of Human Factors Guidelines for Advanced Traveler Information Systems and Commercial Vehicles: ATIS and CVO Development Objectives and Performance Requirements*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-95-109).

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**Wheeler, W.A., Lee, J., Raby, M., Kinghorn, A., Bittner, A.C., and McCallum, M.C. (1996).** *Development of Human Factors Guidelines for Advanced Traveler Information Systems and Commercial Vehicles: Task Analysis of ATIS/CVO Functions*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-95-176).

**The following documents will be available in 1998.**

**Campbell, J.L., Carney, C., and Kantowitz, B.H. (1998).** *Development of Human Factors Guidelines for Advanced Traveler Information Systems and Commercial Vehicles: Human Factors Guidelines for ATIS/CVO*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration.

**Hulse, M.C., Dingus, T.A., Mollenhauer, M.A., Liu, Y.C., Jahns, S.K., Brown, T., and McKinney, B. (1997).** *Development of Human Factors Guidelines for Advanced Traveler Information Systems and Commercial Vehicles: Identification of the Strengths and Weaknesses of Alternate Information Display Formats*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-96-142).

**Kantowitz, B.H., Lee, J.D., Becker, C.A., Bittner, A.C., Kantowitz, S.C. Hanowski, R.J., Kinghorn, R.A., McCauley, M.E., Sharkey, T.J., McCallum, M.C., and Barlow, S.T. (1997).** *Development of Human Factors Guidelines for Advanced Traveler Information Systems and Commercial Vehicles: Identify and Explore Driver Acceptance of In-vehicle ITS Information*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-96-143)

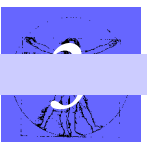
**Open Literature Publications from the  
“Human Factors in ATIS/CVO Design Evolution” Effort**

**Campbell, J.L., Moyer, M.J., Granda, T.M., Kantowitz, B.H., Hooey, B., & Lee, J.D. (1997).** “Applying Human Factors Tools for ITS Research”. *Proceedings of the Society of Automotive Engineers Future Transportation Technology Conference*, 1997, Warrendale, PA: Society of Automotive Engineers.

**Granda, T.M., Moyer, M.J., Hanowski, R.J., and Kantowitz, B.H. (1997).** “Older Driver ATIS Guidelines”. *Proceedings of the American Society of Civil Engineers, Traffic Congestion and Traffic Safety in the 21st Century: Challenges, Innovations, and Opportunities*, 1997, American Society of Civil Engineers: New York.

**Kantowitz, B.H., Hanowski, R.J., and Kantowitz, S.C. (1997).** “Driver Acceptance of Unreliable Traffic Information in Familiar and Unfamiliar Settings”. *Human Factors*, 39, pp. 164-176.

**Kantowitz, B.H., Hanowski, R.J., and Kantowitz, S.C. (1997).** “Driver Reliability Requirements for Traffic Advisory Information”. In I. Noy (Ed.), *Ergonomics of Intelligent Vehicle Highway Systems*, pp. 1-22. Mahwah, NJ: Lawrence Erlbaum Associates.



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**Lee, J.D. (1997).** “A Functional Description of ATIS/CVO Systems to Guide and Accommodate Driver Needs and Limits”. In I. Noy (Ed.), *Ergonomics of Intelligent Vehicle Highway Systems*, pp. 63-84. Mahwah, NJ: Lawrence Erlbaum Associates.

**Lee, J.D., and Kantowitz, B.H. (1997, in Press).** “Perceptual and Cognitive Aspects of Intelligent Vehicle Highway Systems (IVHS)”. In W. Barfield & T. Dingus (Eds.), *Human Factors in Intelligent Vehicle Highway Systems (IVHS)*. Hillsdale, NJ: Lawrence Erlbaum Associates.

**Wheeler, W.A., Campbell, J.L., and Kinghorn, R.A. (1997, in press).** “Commercial Vehicle Operations”. In W. Barfield & T. Dingus (Eds.), *Human Factors in Intelligent Vehicle Highway Systems (IVHS)*. Hillsdale, NJ: Lawrence Erlbaum Associates.

**Campbell, J.L. (1996).** “The Development of Human Factors Design Guidelines”. *International Journal of Industrial Ergonomics*, 18 (5-6), pp. 363-371.

**Hanowski, R.J., Kantowitz, S.C., and Kantowitz, B.H. (April, 1996).** “Driver Memory for In-vehicle Advanced Traveler Information System Messages” [Abstract]. In *Final Program of the Symposium on Night Visibility and Driver Behavior*, 1996, presented by the Transportation Research Board and National Research Council, Iowa City, Iowa.

**Kantowitz, B.H., Granda, T.M., Moyer, M.J., and Campbell, J.L. (1996).** “Using Simulators to Study Driver Response to Advanced In-Vehicle Systems” [Abstract]. *Proceedings of the Third Annual ITS World Congress*, 1996, p.48. Orlando, FL: ITS AMERICA.

**Campbell, J.L. (1995).** “Development of Human Factors Design Guidelines for Advanced Traveler Information Systems (ATIS)”. *Proceedings of the 1995 Pacific Rim TransTech Conference in Association with the Sixth Annual International Conference on Vehicular Navigation and Information Systems (VNIS'95)*, pp. 161-164. Piscataway, NJ: IEEE.

**Campbell, J.L., Kantowitz, B.H., and Hanowski, R.J. (1995).** “Human Factors Design of In-vehicle Traveler Information Systems”. *Proceedings of the Second World Congress on Intelligent Transport Systems*, 1995, pp. 1721-1726. Yokohama, Japan: Intelligent Transportation Systems.

**Campbell, J.L., Kinghorn, R.A., and Kantowitz, B.H. (1995).** “Driver Acceptance of System Features in an Advanced Traveler Information System (ATIS)”. *Proceedings of the ITS 1995 Annual Meeting*, 2, pp. 967-973. Washington DC: ITS AMERICA.

**Kantowitz, B.H., Hanowski, R.J., and Kantowitz, S.C. (1995).** “Driver Reactions to Unreliable Traffic Information”. *Proceedings of the ITE 65th Annual Meeting*, 1995, pp. 673-676. Washington DC: Institute of Transportation Engineers.

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**Kantowitz, S.C., Kantowitz, B.H., and Hanowski, R.J. (1995).** “The Battelle Route Guidance Simulator: a Low-cost Tool for Studying Driver Response to Advanced Navigation Systems”. *Proceedings of the Sixth Annual International Conference on Vehicular Navigation and Information Systems (VNIS'95)*, pp. 104-109. Piscataway, NJ: IEEE.

**Kinghorn, R.A. (1995).** “A Comparison of Two Models to Predict Driver Acceptance of Traveler Information Systems”. In A.C. Bittner, Jr., & P.C. Champney (Eds.), *Advances in Industrial Ergonomics and Safety VII*, pp. 639-646. London: Taylor & Francis.

**Kinghorn, R.A., and Bittner, A.C., Jr. (1995).** “Truck Driver Anthropometric Data: Estimating the Current Population”. *International Journal of Industrial Ergonomics*, 15, pp. 199-204.

**Dingus, T.A., and Hulse, M.C. (1994).** “Human Factors Analysis of Information Format Options For Advanced Traveler Information Systems”. *Proceedings of the International Ergonomics Association 12th Triennial Congress*, 4, pp. 136-139. Toronto, Canada: Human Factors Association of Canada.

**Hanowski, R.J., Kantowitz, S.C., and Kantowitz, B.H. (1994).** “Driver Acceptance of Unreliable Route Guidance Information”. *Proceedings of the Human Factors and Ergonomics Society 38th Annual Meeting*, 1994, pp. 1062-1066. Santa Monica, CA: Human Factors and Ergonomics Society.

**Kantowitz, B.H., Kantowitz, S.C., and Hanowski, R.J. (1994).** “Driver Reliability Demands for Route Guidance Systems”. *Proceedings of the International Ergonomics Association 12th Triennial Congress*, 4, pp. 133-135. Toronto, Canada: Human Factors Association of Canada.

**Kantowitz, B.H., Lee, J.D., and Kantowitz, S.C. (1994).** “Prioritizing Human Factors Research Issues for IVHS”. *Proceedings of the First World Congress on Applications of Transport Telematics & Intelligent Vehicle-Highway Systems*, 1994, pp. 2200-2207. Paris, France.

**Kinghorn, R.A., Bittner, A.C., and Kantowitz, B.H. (1994).** “Identification of Desired System Features in an Advanced Traveler Information System”. *Proceedings of the Human Factors and Ergonomics Society 38th Annual Meeting*, 1994, pp. 1067-1071. Santa Monica, CA: Human Factors and Ergonomics Society.

**Lee, J.D., Kantowitz, B.H., Hulse, M.C., and Dingus, T.A. (1994).** “Functional Description of Advanced In-Vehicle Information Systems: Development and Application”. *Proceedings of the First World Congress on Applications of Transport Telematics & Intelligent Vehicle-Highway Systems*, 1994, pp. 2369-2376. Paris, France.

**Lee, J.D., Morgan, J., Raby, M., and Wheeler, W.A. (1994).** “Accommodating Driver Needs and Limits: a Functional Description of ATIS/CVO Systems”. *Proceedings of the International Ergonomics Association 12th Triennial Congress*, 4, pp. 140-142. Toronto, Canada: Human Factors Association of Canada.



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**Lee, J.D., and Raby, M. (1994).** "Network Analysis as a Technique to Guide the Task Analysis of ATIS/CVO". *Proceedings of the Human Factors Society 38th Annual Meeting*, 1994, pp. 1018-1022. Santa Monica, CA: Human Factors and Ergonomics Society.

**McCauley, M.E., Clark, D.L., Sharkey, T.J., and Dingus, T.A. (1994).** "Comparable Systems Analysis of Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO) and Comparable Systems". *Proceedings of the International Ergonomics Association 12th Triennial Congress*, 4, pp. 143-145. Toronto, Canada: Human Factors Association of Canada.

**Mollenhauer, M.A., Lee, J., Cho, K., Hulse, M.C., and Dingus, T.A. (1994).** "The Effects of Sensory Modality and Information Priority on In-Vehicle Signing and Information Systems". *Proceedings of the Human Factors Society 38th Annual Meeting*, 1994, pp. 1072-1076. Santa Monica, CA: Human Factors and Ergonomics Society.

**Wheeler, W.A., Lee, J.D., Raby, M., Kinghorn, R.A., Bittner, A.C., Jr., and McCallum, M.C. (1994).** "Predicting Driver Behavior Using Advanced Traveler Information Systems". *Proceedings of the Human Factors and Ergonomic Society 38th Annual Meeting*, 1994, pp. 1057-1061. Santa Monica, CA: Human Factors and Ergonomics Society.

**Dingus, T.A., and Hulse, M.C. (1993).** "Human Factors Research Recommendations for the Development of Design Guidelines for Advanced Traveler Information Systems". *Proceedings of the Human Factors Society 37th Annual Meeting*, 1993, pp. 1067-1071. Seattle, WA: Human Factors Society.

**Kantowitz, B.H., Becker, C.A., and Barlow, T. (1993).** "Assessing Driver Acceptance of IVHS Components". *Proceedings of the Human Factors Society 37th Annual Meeting*, 1993, pp. 1062-1066. Seattle, WA: Human Factors Society.

**Kinghorn, R.A., and Bittner, A.C., Jr. (1993).** "Truck Driver Anthropometric Data: Estimating the Current Population". *Proceedings of the Human Factors Society 37th Annual Meeting*, 1993, pp. 580-584. Seattle, WA: Human Factors Society.

**McCallum, M. C., and Lee, J. D. (1993).** "System Objectives and Performance Requirements of ATIS and Commercial Vehicle Components of IVHS". *Proceedings of the Human Factors Society 37th Annual Meeting*, 1993, pp. 1072-1076. Seattle, WA: Human Factors Society.

**Ng, L., and Barfield, W. (1993).** "User Information Requirements for Intelligent Vehicle Highway Systems as a Function of Driver Category". *Proceedings of the Human Factors Society 37th Annual Meeting*, 1993, pp. 1077-1081. Seattle, WA: Human Factors Society.



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**Title:** Human Factors Aspects of the Transfer of Control from the Automated Highway System to the Driver

**Contract Number:** DTFH61-89-C-00100

**Prime Contractor:** Honeywell Inc.

**Purpose:** This effort has provided timely human factors input during the conceptual stages of AHS development to aid in the design and implementation of AHS technology, as well as to provide the foundation for the future advancement of AHS objectives.

**Status:** In-Progress

## Publications:

**Bloomfield, J.R., Carrol, S.A., Papelis, Y.E., and Bartelme, M.J. (1996).** *The Driver's Response to an Automated Highway System with Reduced Capability.* Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-96-067).

**Bloomfield, J.R., Christensen, J.M., Carrol, S.A., and Watson, G.S. (1996).** *The Driver's Response to Decreasing Vehicle Separation During Transition into the Automated Lane.* Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-95-107).

**Bloomfield, J.R., Christensen, J.M., Peterson, A.D., Kjaer, J.M., and Gault, A. (1996).** *Human Factors Aspects of Transferring Control from the Driver to the AHS with Varying Degrees of Automation.* Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-95-108).

**Levitan, L. (1996).** *Human Factors Design of AHS: Stage I Interim Report.* Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-96-110).

**Levitan, L., and Bloomfield, J. (1996).** *Drivers' Activities and Information Needs in an AHS.* Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-96-066).

**Bloomfield, J.R., Buck, J.R., Carroll, S.A., Booth, M.S., Romano, R.A., McGehee, D.V., and North, R.A. (1995).** *Human Factors Aspects of the Transfer of Control from AHS to the Driver.* Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-194-114).

**Bloomfield, J.R., Buck, J.R., Christensen, J.M., and Yenamandra, A. (1995).** *Human Factors Aspects of the Transfer of Control from the Driver to the AHS.* Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-94-173).

**Bloomfield, J.R., Christensen, J.M., and Carroll, S.A. (1995).** *The Effect on Normal Driving Behavior after Traveling under Automated Control.* Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-95-182)



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**Levitan, L., Burrus, M., Dewing, W.L., Reinhart, W.F., Vora, P., and Llaneras, R.E. (1995).** *Preliminary Human Factors Guidelines for Automated Highway System Designers (Volumes I and II)*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-94-116, FHWA-RD-95-053).

**Tsao, H.S., Hall, R.W., Shladover, S.E., Plocher, T.A., and Levitan, L.J. (1994).** *Human Factors Design of AHS: First Generation Scenarios*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-94-123).

**The following documents will be available early 1998.**

**Bloomfield, J.R., Grant, A.R., Levitan, L., Christensen, J.M., Brown, T.L., Cumming, T.L., Reinach, S.J., and Watson, G.S.** *Driving Performance and Commuting via an Automated Highway System*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (in press).

**Levitan, L.** *Human Factors Design of AHS: Final Report*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (draft under review)

**Levitan, L., Burrus, M., Dewing, W.L., Reinhart, W.F., Vora, P., and Llaneras, R.E.** *Final Human Factors Guidelines for Automated Highway System Designers*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (anticipated winter 1997).

**Bloomfield, J.R., Levitan, L., Grant, A.R., Brown, T.L., and Hankey, J.M.** *Driving Performance After an Extended Period of Travel in an Automated Highway System*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (draft under review)

**Bloomfield, J.R., Grant, A.R., Levitan, L., Cumming, T.L., Maddhi, S., Brown, T.L., and Christensen, J.M.** *Using an Automated Speed, Steering, and Gap Control System and a Collision Warning System When Driving in Fog*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (draft under review)

**Open Literature Publications from the**

**“Human Factors Aspects of the Transfer of Control from the Automated Highway System to the Driver” Effort**

**Levitan, L., and Bloomfield, J.R. (1997 in press).** “Human Factors Design of Automated Highway Systems”. In Barfield, W., and Dingus, T. (Eds) *Human Factors Considerations In Intelligent Transportation Systems*. Lawrence Erlbaum Associates, Hillsdale, N.J.

**Bloomfield, J.R. and Carroll, S.A. (1996).** “New Measures of Driving Performance”. In Robertson, S.A. (Ed.) *Contemporary Ergonomics 1996*, pp. 335-340, Taylor and Francis, London.





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**Bloomfield, J.R. (1995).** “Experimental Investigation of Human Factors and Automated Highway Systems”. Paper presented at the Intelligent Transportation Society of America AVCS/Safety and Human Factors Joint Committee Meeting, Iowa City, Iowa, 20 July, 1995.

**Bloomfield, J.R. (1995).** “On the Transfer of Control Between the Driver and the Automated Highway System”. Paper presented at the Ergonomics Society Annual Conference, University of Canterbury, Kent, England 4-6 April, 1995.

**Bloomfield, J.R., Christensen, J.M., Carroll, S.A., and Watson, G.S. (1995).** “The Driver’s Response to Decreasing Vehicle Separations During Transitions into the Automated Lane”. Paper presented at the Sixth International Conference on Vision in Vehicles, University of Derby, Derbyshire, England, 13-16 September, 1995.

**Bloomfield, J.R., Christensen, J.M., Peterson, A.D., Kjaer, J.M., and Gault, A. (1995)** “Transferring Control from the Driver to the Automated Highway System with Varying Degrees of Automation”. Paper presented at the Sixth International Conference on Vision in Vehicles, University of Derby, Derbyshire, England, 13-16 September, 1995.

**Bloomfield, J.R. (1994).** “Automated Highway System (AHS) Human Factors Experiments”. Paper presented at the Automated Highway System Precursor Analysis Conference, Chantilly, Virginia, 16-18 November 1994.

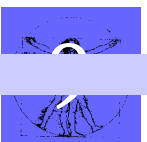
**Bloomfield, J.R. (1994).** “Investigating Human Factors Aspects of the Automated Highway System with the Iowa Driving Simulator”. Paper presented at IMAGE VII Conference, 12-17 June, 1994.

**Bloomfield, J.R., Buck, J.R., and Carroll, S.A. (1994).** “The Feasibility of an Automated Highway System with the Automated and Unautomated Lanes Adjacent to Each Other, with No Intervening Transition Lane or Barriers”. Paper presented at the Ergonomics Society Annual Conference, University of Warwick, Coventry, England, 19-22 April 1994.

**Buck, J.R., Yenamandra, A., and Bloomfield, J.R. (1994).** “Ergonomic Issues Related to Vehicle Entry into an Automated Highway System”. Paper presented at the International Ergonomic Association Conference in Toronto, Canada, 15-17 August 1994.

**Bloomfield, J.R., and Buck, J.R. (1993).** “The Effects of Headway, Velocity, and Traffic Density on the Transfer of Control from System to Driver in the Automated Highway System”. Paper presented at the Fifth International Conference on Vision in Vehicles, University of Glasgow, 9-11 September, 1993.

**Bloomfield, J.R., Buck, J.R., and Plocher, T. (1993).** “Human Factors Considerations in the Transfer of Control from System to Driver in the Automated Highway System”. Paper presented at the Fifth International Conference on Vision in Vehicles, University of Glasgow, 9-11 September, 1993.



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Buck, J.R., Stoner, J., Bloomfield, J.R., and Plocher, T. (1993). "Driving Research and the Iowa Driving Simulator". In: E. J. Lovesey (Ed.), *Contemporary Ergonomics 1993*, pp. 392-396, Taylor and Francis, London.

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**Title:** Human Factors in Advanced Traffic Management Systems Design Evolution

**Contract Number:** DTFH61-89-C-00094

**Prime Contractor:** Georgia Tech Research Institute

**Purpose:** The goal of this contract is to develop a human factors handbook tailored to the needs of operators of new or existing TMCs which are currently upgrading their control centers to ITS-class TMCs.

**Status:** In-Progress

## Publications:

**Georgia Tech Research Institute (1996).** *Human Factors Handbook for Advanced Traffic Management Center Design (First Edition)*. Atlanta, GA: Georgia Institute of Technology.

**Mitta, D.A., Kelly, M.J., and Folds, D. J. (1996).** *Design of an ITS-Level Advanced Traffic Management System*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-95-181).

**Kelly, M.J., Gerth, J.M., and Whaley, C.J. (1995).** *Comparable Systems Analysis: Design and Operation of Advanced Control Centers*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-94-147).

**Kelly, M.J., Gerth, J.M., and West, P.D. (1994).** *Comparable Systems Analysis: Evaluation of Ten Command Centers as Potential Sites*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-93-158).

**The following document will be available early 1998.**

**Georgia Tech Research Institute.** *Human Factors Handbook for Advanced Traffic Management Center Design (Second Edition)*. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (in review).

**Open Literature Publications from the**

**"Human Factors in Advanced Traffic Management Systems Design Evolution" Effort**

**Beers, T.M., & Folds, D.J. (1996).** "An Evaluation of Monitor Viewing Distance for Text and Video Interpretation Tasks". Paper presented at the Third World Congress on Intelligent Transport Systems, 1996, Orlando, FL.

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**Coon, V.E., & Folds, D.J. (1996).** “A Comparison of Manual, Preset, and Hybrid Remote Camera Control Configurations in a Traffic Management Center Simulator”. Paper presented at the Third World Congress on Intelligent Transport Systems, 1996, Orlando, FL.

**Folds, D.J., and Mitta, D.A. (1996).** “Applying Operator Role Theory to the Function Allocation Process”. In R.J. Koubek and W. Karwowski (Eds.) *Manufacturing Agility and Hybrid Automation - I, Proceedings of the 5th International Conference on Human Aspects of Advanced Manufacturing: Agility and Hybrid Automation*, pp. 640-643. Louisville, KY: IEA Press.

**Mitta, D.A., Folds, D.J., & Fain, W.B. (1996).** “Human Factors Issues in the Design of Incident Detection Support Systems”. Paper presented at the Third World Congress on Intelligent Transport Systems, 1996, Orlando, FL.

**Stocks, D.R., Folds, D.J., & Gerth, J.M. (1996).** “Lessons Learned During Development of Simulated Support Systems for the TMC Operator”. Paper presented at the Third World Congress on Intelligent Transport Systems, 1996, Orlando, FL.

**Whaley, C.J. & Folds, D.J. (1996).** “Integrated ATMS/ATIS Simulator for Human Factors Research”. Paper presented at the Third World Congress on Intelligent Transport Systems, 1996, Orlando, FL.

**Farbry, J.E. (1995).** “Considerations in the Development of the Human Factors ATMS Handbook”. *Proceedings of the ITE 65th Annual Meeting*, 1995, pp. 691-694. Denver, CO: Institute of Transportation Engineers.

**Folds, D.J., Kelly, M.J., and Sobhi, N.(1995).** “Human Factors in the Design and Operation of Advanced Traffic Management Centers”. *Proceedings of the ITE 65th Annual Meeting*, 1995, pp. 657-659. Denver, CO: Institute of Transportation Engineers.

**Ingle, R.M. (1995).** “Architecture of a Simulator for Research in Advanced Traffic Management System Design”. Paper presented at the European Simulator Conference, Vienna, Austria.

**Folds, D.J., Kelly, M.J., Mitta, D.A. (1994).** “Human Factors Experimentation in the IVHS TMC Simulator”. Presented at the First World Congress on Applications of Transport Telematics and Intelligent Vehicle-Highway Systems, 1994, pp. 1709-1716. Paris, France.

**Gerth, M.M., West, P.D., & Sobhi, N. (1994).** “Comparing Advanced Traffic Management Centers with Similar Operation Control Systems”. *Proceedings of the 12th Triennial Congress of the International Ergonomics Association*, 1994, pp. 212-215. Toronto, Canada: International Ergonomics Association

**Ingle, R.M., Williams, B.D., & Sobhi, N. (1994).** “An Advanced Traffic Management System Simulator for Intelligent Vehicle-Highway Systems Research”. Paper presented at the IEEE/ACM Winter Simulation Conference, Orlando, FL.



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**Kelly, M.J. (1994).** “Emerging Automation Approaches in Roadway Traffic Management”. In P.T. Kidd and W. Karwowski (Eds.) *Advances in Agile Manufacturing - Integrating Technology, Organization and People, Proceedings of the 4th International Conference on Human Aspects of Advanced Manufacturing and Hybrid Automation*, pp.491-494. Manchester, England: IEA Press.

**Kelly, M.J., Folds, D.J., Ingle, R.M. & Sobhi, N. (1994).** “A Traffic Management Center Simulator for Human Factors Research”. Proceedings of the 12th Triennial Congress of the International Ergonomics Association, 1994, pp. 206-208. Toronto, Canada: International Ergonomics Association

**Kelly, M.J., Folds, D.J. & Sobhi, N. (1994).** “Human Factors Guidelines for Advanced Traffic Management Center Design”. Proceedings of the First World Congress on Applications of Transport Telematics and Intelligent Vehicle-Highway Systems, 1994, pp. 1742-1749. Paris, France.

## Human Factors Highway Safety Research Program

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**Title:** Symbol Signing Design for Older Drivers

**Contract Number:** DTFH61-91-C-00018

**Prime Contractor:** Swanson Transportation Consultants, Ltd.

**Purpose:** This study examined drivers' abilities to comprehend and perceive symbol signs and resulted in a technique for optimizing these types of signs.

**Status:** Complete

## Publications:

**Swanson, A., Dewar, R., Schieber, F., and Kline, D. (1997).** Symbol Signing Design for Older Drivers. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-94-069) (In print)

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**Schieber, F. (1995).** “Fourier Techniques for Optimizing Symbol Highway Sign Legibility”. Proceedings of the ITE 65th Annual Meeting, 1995, pp. 601-604. Washington DC: Institute of Transportation Engineers.

**Dewar, R. and Ells, J. (1994).** “The Design and Evaluation of Traffic Signs”. Proceedings of the 12th Triennial Congress of the International Ergonomics Association, Volume 4: Ergonomics and Design, 1994, pp. 221-223. Ontario, Canada: Human Factors Association of Canada.

**Schieber, F. and Kline, D.W. (1994).** “Age Differences in the Legibility of Symbol Highway Signs as a Function of Luminance and Glare Level: A Preliminary Report”. Proceedings of the Human Factors and Ergonomics Society 38th Annual Meeting, 1994, pp. 133-136. Santa Monica, CA: Human Factors and Ergonomic Society.



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**Schieber, F., Kline, D. W., Dewar, R.E. (1994).** “Optimizing Symbol Highway Signs for Older Drivers”. Proceedings of the 12th Triennial Congress of the International Ergonomics Association, Volume 6: Part 2 -General Issues in Ergonomics, 1994, pp. 199-201. Ontario, Canada: Human Factors Association of Canada.

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**Title:** Traffic Operations Control for Older Drivers

**Contract Number:** DTFH61-91-C-00033

**Prime Contractor:** Center for Advanced Research (CAR)

**Purpose:** This study was conducted to define the safety problems of older drivers and pedestrians and develop recommendations (such as signs) to accommodate the needs of the older road user population.

**Status:** Complete

## **Publications:**

**Knoblauch, R., Nitzburg, M., Reinfurt, D., Council, F., Zegeer, C., and Popkin, C. (1995).** Traffic Operations Control for Older Drivers. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-94-119).

**Dewar, R. (1995).** “Intersection Design for Older Driver and Pedestrian Safety”. Proceedings of the ITE 65th Annual Meeting, 1995, pp. 605-608. Washington DC: Institute of Transportation Engineers.

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**Title:** Driving Simulation of Raised Pavement Markers (RPM)

**Contract Number:** DTFH61-94-C-00120

**Prime Contractor:** The University of Iowa

**Purpose:** This study is investigating different elements of Raised Pavement Markers to assess how the combination of pattern, placement, and color effect driving performance.

**Status:** In Progress

## **Publications:**

**Bloomfield, J.R., Brown, T.L., Durlak, C.F., and Bartelme, M.J. (Expected 1998).** The Effect of Varying the Spacing, Reflectivity and Location of Retroreflective Raised Pavement Markers (RRPMs) on Driving Performance. Washington, DC: U.S. Department of Transportation, Federal Highway Administration.

**Grant, A.R., and Bloomfield, J.R. (Expected 1998).** Guidelines for the Use of Raise Pavement Markers (RPMs). Washington, DC: U.S. Department of Transportation, Federal Highway Administration.



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**Bartelme, M.J., Watson, G.S., Dingus, T.A., and Stoner, J.W. (1995).** “Driving Simulation Studies of Raised Pavement Markers for Roadway Delineation”. Proceedings of the ITE 65th Annual Meeting, 1995, pp. 609-613. Washington DC: Institute of Transportation Engineers.

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**Title:** Pavement Markings and Delineation of Hazards for Older Drivers

**Contract Number:** DTFH61-90-C-00062

**Prime Contractor:** The Pennsylvania Transportation Institute

**Purpose:** This study assessed the pavement markings and delineation needs of older drivers and offered recommendations to improve older drivers’ performance, especially on curves.

**Status:** Complete

## **Publications:**

**Pietrucha, M.T., Hostetter, R.S., Staplin, L., and Obermeyer, M. (1995).** Pavement Markings and Delineation for Older Driver, Volume 1: Final Report. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-94-145).

**Pietrucha, M.T., Hostetter, R.S., Staplin, L., and Obermeyer, M. (1996).** Pavement Markings and Delineation for Older Drivers, Executive Summary. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-95-118).

**Pietrucha, M.T., Hostetter, R.S., and Staplin, L. (1995).** “Markings and Delineation for Older Drivers”. Proceedings of the ITE 65th Annual Meeting, 1995, pp. 614-618. Washington DC: Institute of Transportation Engineers.

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**Title:** Intersection Geometric Design for Older Drivers and Pedestrians

**Contract Number:** DTFH61-92-C-00142

**Prime Contractor:** Scientex Corporation

**Purpose:** This study focused on the geometric and operational aspects of intersections and resulted in design recommendations to improve left hand turning maneuvers, especially for older drivers.

**Status:** Complete

## **Publications:**

**Staplin, L., Harkey, D.L., Lococo, K.H., and Tarawneh, M.S. (1997).** Intersection Geometric Design for Older Drivers and Pedestrians, Volume 1: Final Report. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-96-132).



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**Staplin, L., Harkey, D.L., Lococo, K.H., and Tarawneh, M.S. (1997).** Intersection Geometric Design for Older Drivers and Pedestrians, Volume II: Executive Summary. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-96-138).

**Staplin, L., Harkey, D.L., Lococo, K.H., and Tarawneh, M.S. (1997).** Intersection Geometric Design for Older Drivers and Pedestrians, Volume III: Guidelines. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-96-137).

**Staplin, L., Lococo, K., and Sim, J. (1993).** Traffic Maneuver Problems of Older Drivers. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-92-092).

**Harkey, D. L. (1997).** “Engineering Solutions to Enhance the Safety and Mobility of Older Persons”, 30th Annual Human Factors Workshop of the Transportation Research Board, 1997, Washington DC.

**Harkey, D.L. (1995).** “Intersection Geometric Design Issues for Older Drivers and Pedestrians”. Proceedings of the ITE 65th Annual Meeting, 1995, pp. 619-623. Washington DC: Institute of Transportation Engineers.

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**Title:** Older Driver Perception-Reaction Time for Intersection Sight Distance and Object Detection

**Contract Number:** DTFH61-90-C-00038

**Prime Contractor:** Comsis

**Purpose:** This study evaluated AASHTO perception-reaction time guidelines for minimum intersection sight distance and object detection with particular attention as to how these guidelines affected the driving performance of the older driver population.

**Status:** Complete

## **Publications:**

**Lerner, N.D., Huey, R.W., McGee, H.W., and Sullivan, A. (1994).** Older Driver Perception-Reaction Time for Intersection Sight Distance and Object Detection, Volume III -Executive Summary. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-93-170).

**Lerner, N.D., Huey, R.W., McGee, H.W., and Sullivan, A. (1994).** Older Driver Perception-Reaction Time for Intersection Sight Distance and Object Detection, Volume I-Final Report. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-93-168).

**Kloeppe, E., Peters, R.D., James, C., Fox, J.E., and Alicandri, E. (1996).** Comparison of Older and Younger Driver Responses to Emergency Events. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-95-056).



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**Lerner, N.D. (1995).** “Age and Driver Perception-Reaction Time for Sight Distance Design Requirements”. Proceedings of the ITE 65th Annual Meeting, 1995, pp. 624-628. Washington DC: Institute of Transportation Engineers.

**Lerner, N.D. (1994).** “Giving the Older Driver Enough Perception Reaction Time”. Experimental Aging Research, 20(1), pp. 25-33.

**Lerner, N.D. (1993).** “Brake Perception-Reaction Times of Older and Younger Drivers”. Proceedings of the Human Factors and Ergonomics Society 37th Annual Meeting, 1993, pp. 206-210. Santa Monica, CA: Human Factors and Ergonomic Society.

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**Title:** Relative Visibility of Increased Legend Size vs. Brighter Materials

**Contract Number:** DTFH61-90-C-00015

**Prime Contractor:** Last Resource, Inc.

**Purpose:** This study evaluated different signing factors (font size, sheeting material, brightness) to determine the most effective factors for increasing sign visibility and legibility.

**Status:** Complete

**Publications:**

**Mace, D.J., Garvey, P.M., and Hechard, R.F. (1995).** Relative Visibility of Larger Signs vs. Brighter Materials for Traffic Signs. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-94-035).

**Mace, D.L., (1993).** “The Effects of Increased Character Height on Sign Legibility”. 72nd Annual Transportation Research Board Annual Meeting, Washington, DC.

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**Title:** Delineation of Hazards for Older Drivers

**Contract Number:** DTFH61-92-C-00043

**Prime Contractor:** COMSIS

**Purpose:** This study was conducted to identify problems drivers, especially older drivers, have with hazard markers and assess what types of improvements would increase the markers' comprehension and conspicuity.

**Status:** Complete

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## Publications:

**Lerner, N., Benel, D.C.R., Huey, R.W., and Steinberg, G.V. (1997).** Delineation of Hazards for Older Drivers, Volume I. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-96-161).

**Lerner, N.D, Benel, D.C.R., Huey, R.W., and Steinberg, G.V. (1997).** Delineation of Hazards for Older Drivers, Volume II: Appendixes. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-96-162).

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**Title:** Investigation of Older Driver Freeway Needs and Capabilities

**Contract Number:** DTFH61-92-C-00085

**Prime Contractor:** Center for Applied Research (CAR)

**Purpose:** This project identified those elements of highway driving that are problematic for older drivers.

**Status:** Complete

## Publications:

**Knoblauch, R., Nitzburg, M., and Seifert, R. (1996).** An Investigation of Older Driver Freeway Needs and Capabilities. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-95-194).

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**Title:** Synthesis of Human Factors Research on Older Drivers and Highway Safety

**Contract Number:** DTFH61-93-C-00074

**Prime Contractor:** Scientex Corporation

**Purpose:** This project provided a comprehensive synthesis of older driver research results which were compiled into the Older Driver Highway Design Handbook.

**Status:** Complete

## Publications:

**Staplin, L., Lococo, K., and Byington, S. (1997).** Older Driver Highway Design Handbook. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (in print).



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**Golembiewski, G., Kloeppel, E. (1995).** "Design Tools for Improving Highway Safety: The Development of Human Factors Safety Handbooks at FHWA". Proceedings of the ITE 65th Annual Meeting, 1995, pp. 644-646. Washington DC: Institute of Transportation Engineers.

**Alicandri, E., and Golembiewski, G. (1994).** "Improved Highway Design Standards for Older Drivers". Proceedings of the 12th Triennial Congress of the International Ergonomics Association Volume 6: Part 2 - General Issues in Ergonomics, 1994, pp. 191-192. Ontario, Canada: Human Factors Association of Canada.

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**Title:** Design Characteristics of Older Adult Pedestrians

**Contract Number:** DTFH61-91-C-00028

**Prime Contractor:** Center for Applied Research (CAR)

**Purpose:** This study developed guidelines for the design of pedestrian facilities for older persons to be utilized by traffic planners and engineers.

**Status:** Complete

## **Publication:**

**Knoblauch, R and Nitzburg, M. (1994).** Older Pedestrian Characteristics for Use in Highway Design. U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-93-177).

## **Select In-House Staff Research Publications**

Staff research emphasizes human factors issues as they relate to FHWA procedures for both highway safety and ITS technology. The following select In-House Research publications are from staff studies conducted in one of four human factors laboratories at Turner-Fairbank Highway Research Center. These laboratories have increasing levels of fidelity and labor intensiveness: the SIGNSIM, VIDSIM, HYSIM, and the Human Factors Field Research Vehicle (HFFRV). Each lab is designed for particular types of research investigations which can be performed in a series, advancing from the lower-level to the higher-level simulators and eventually to the field.

**Fox, J. and Philips, B., (1997).** Sign Study. Washington, DC: U.S. Department of Transportation, Federal Highway Administration. (FHWA-RD-94-069) (in print)

**James, C., Ehret, B., James, W.S., Philips, B., and Alicandri, E. (1997).** The Effects of Display Rotation and Location in an Advanced Traveler Information System (ATIS) Intersection Matching Task. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-97-024).

**Mahach, K., Knoblauch, R., Simmons, C., Nitzburg, M., and Tignor, S. (1997).** Safety Evaluation of Ultraviolet-Activated Fluorescent Roadway Delineation: Preliminary Field Experiments. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-97-033)

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**Marshall, R. and Mahach, K. (1997 in print).** The Effects of IVIS on Driver Response to Stop Signs and Traffic Signals on a Simulated Rural Highway. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-96-213).

**Wochinger, K. and Boehm-Davis, D. (1996).** The Effects of Age, Spatial Ability and Navigational Information on Navigational Performance. Washington, DC: U.S. Department of Transportation, Federal Highway Administration (FHWA-RD-95-166).

**Kloeppel, E., Peters, R., James, C., Fox J., and Alicandri, E. (1995).** A Comparison of Older and Younger Drivers' Responses to Emergency Driving Events. Washington, DC: U.S. Department of Transportation, Federal Highway Administration. (FHWA-RD-95-056).

**Bridwell, N., Alicandri, E., Fischer, D., and Kloeppel, E. (1993).** A Preliminary Laboratory Investigation of Passive Railroad Crossing Signs. Washington, DC: U.S. Department of Transportation, Federal Highway Administration. (FHWA-RD-93-153).

**Walker, J., Sedney, C.A., Wochinger, K., Boehm-Davis, D., Perez, W., and Mast, T. (1992).** Older Drivers and Useful Field of View in a Part-Task Simulator: A Follow-Up Study. Washington DC: U.S. Department of Transportation, Federal Highway Administration. (FHWA-RD-92-102).

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**James C.L., Wochinger, K., James, W.S., and Boehm-Davis, D. (1997).** "Visual, Perceptual, and Cognitive Measures as Predictors of Collision Detection in Older Drivers". Proceedings of the Human Factors and Ergonomics Society 41st Annual Meeting, 1997, pp. 1018-1022. Albuquerque, NM: Human Factors & Ergonomics Society.

**Mahach, K., Knoblauch, R., Simmons, C., Nitzburg, M., and Tignor, S. (1997).** "Safety Evaluation of Ultraviolet-Activated Fluorescent Roadway Delineation: Preliminary Field Experiments". *Public Roads*, Vol. 61, No. 1

**Schieber, F., and Goodspeed, C. IV (1997).** Nighttime Conspicuity of Highway Signs as a Function of Sign Brightness, Background Complexity and Age of the Observer. Proceedings of the Human Factors and Ergonomics Society 41st Annual Meeting, 1997, pp. 1362-1366. Albuquerque, NM: Human Factors & Ergonomics Society.

**Wochinger, K. and Boehm-Davis, D. (1997).** "Navigational Preference and Driver Acceptance of Advanced Traveler Information Systems (ATIS)". In Ian Noy (Ed.) *Ergonomics and Safety of Intelligent Driver Interfaces*. Hillsdale, NJ: Lawrence Erlbaum Associates.

**Wochinger, K., Philips, B., and Boehm-Davis, D. (1997).** "The Effects of Spatial Scanning Ability, Perceptual Speed, Age, and Navigation Aid on Navigation Performance." Proceedings of the Human Factors and Ergonomics Society 41st Annual Meeting, 1997, pp. 1013-1017. Albuquerque, NM: Human Factors & Ergonomics Society.



